Immigration and Generational Trends in Body Mass Index and Obesity in the United States: Results of the National Latino and Asian American Survey, 2002–2003

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Objectives. We examined patterns of body mass index (BMI) and obesity among a nationally representative sample of first-, second-, and third-generation Latinos and Asian Americans to reveal associations with nativity or country of origin.

Methods. We used data from the National Latino and Asian American Survey (2002–2003) to generate nationally representative estimates of mean BMI and obesity prevalence and explored changes in the distribution of BMI by generational status. Analyses tested the association between generational status and BMI and examined whether this association varied by ethnicity, education, or gender.

Results. We found substantial heterogeneity in BMI and obesity by country of origin and an increase in BMI in later generations among most subgroups. The data suggest different patterns for Latinos and Asian Americans in the nature and degree of distributional changes in BMI with generational status in the United States.

Conclusions. Generational status is associated with increased BMI and obesity among Latinos and Asian Americans. Aggregate estimates not accounting for nativity and country of origin may mask significant heterogeneity in the prevalence of obesity and patterns of distributional change, with implications for prevention strategies. (*Am J Public Health.* 2007;97:70–77. doi:10.2105/AJPH.2006.102814)

Obesity is widely recognized as a significant and growing health problem in the United States.[1–9] Although racial/ethnic variation in obesity and obesity-related morbidity and mortality has been observed in several studies,[5,10,11] data on racial/ethnic patterns in obesity and body mass index (BMI) in the United States are limited. For example, the National Health and Nutrition Examination Survey, the primary data source for monitoring national prevalence trends in the United States, only reports results for non-Hispanic Whites, non-Hispanic Blacks, and Mexican Americans. In particular, there is a relative dearth of data on BMI and obesity among Asian Americans, overall and by national origin subgroup.[12–14] Analyses that also take nativity into account are even rarer; only a handful of studies report indicators of adiposity by time in the United States.[12,15–20] All but 3 of these investigations used the same data source (the National Health Interview Survey).[15,16,18] These studies typically found lower levels of obesity among first-generation immigrants than among subsequent generations and higher obesity with longer US residence among the foreign born.

Several considerations motivated our examination of patterns of BMI and obesity by generation. As with other health outcomes, aggregate prevalence estimates may mask important heterogeneity. In particular, populations with high proportions of foreign-born individuals (such as many groups of Asian origin or descent) may have relatively low rates of morbidity and mortality that are driven largely by their preponderance of healthy immigrants[12] and may be likely to change as the generational distribution of the population evolves. Moreover, immigrants and their US-born offspring are a rapidly increasing proportion of the total US population. Understanding the patterning of obesity by nativity is important for forecasting trends in prevalence and related morbidity and for identifying vulnerable populations for intervention. It can also elucidate etiologic processes related to changes in the physical, social, economic, and normative environment that influence patterns of obesity.

To improve understanding of the distribution of BMI and obesity by ethnicity and generational status in the United States, we used data from the National Latino and Asian American Survey to generate nationally representative estimates of mean BMI and prevalence of obesity for Latino and Asian American adults overall and by subgroups defined by place of origin or ancestry, education (as a measure of socioeconomic position), and gender. We especially focused on how patterns of BMI distribution and obesity vary by generation among these groups, comparing first-, second-, and third-generation Latinos and Asian Americans.

METHODS

Sample Design and Data Collection

The National Latino and Asian American Survey, a population survey of psychiatric morbidity, was a stratified area probability sample of Latino and Asian American adults recruited in 2002 to 2003 from the noninstitutionalized population of the United States. Eligibility criteria included age (18 years and older), ethnicity (Latino or Asian), and language (English, Spanish, Vietnamese, Chinese, or Tagalog). The sample design and data collection processes are described in full elsewhere.[21,22] The sample was stratified by ethnicity or ancestry (Puerto Rican, Cuban, Mexican, Other Latinos, Chinese, Filipino, Vietnamese, and Other Asians).

The survey first generated a nationally representative sample of all national-origin groups independent of geographic residential patterns and then oversampled areas with a moderate-to-high density (5% or more) of

Latinos and Asian Americans. Sample weights were used to correct for joint probabilities of selection. The final pooled, weighted sample was nationally representative and included 4649 respondents—2554 Latinos and 2095 Asian Americans. Data were collected in person by bilingual proficient interviewers. Written informed consent was obtained in the respondent's preferred language. The overall response rate was 75.5% for Latinos and 65.6% for Asian Americans.

Measures

BMI (weight in kilograms divided by height in meters squared) was measured with self-reported height and weight converted to a metric scale (kg/m^2). For the categorical BMI outcome, we followed the National Institutes of Health guidelines[23] and defined obesity as BMI $\geq$ 30 kg/m^2.

For the primary exposure of interest, generational status, respondents were considered first generation if they were not born in the mainland United States, Alaska, or Hawaii; those born in Puerto Rico were classified as first generation even though they were US citizens by birth. The second generation comprised individuals born in the United States with at least 1 foreign-born parent. This categorization corresponded to the definition of second generation commonly used in the literature.[24–27] Some argue that this definition inappropriately conflates individuals with 1 foreign-born parent and those with 2, despite evidence that those groups may diverge in demographic, socioeconomic, or health outcomes.[28,29] However, our sample distribution did not allow examination of these groups separately. Third-generation respondents were those born in the United States whose parents (both of them and possibly grandparents; this category refers to those who were third generation or later) were also born in the United States.

Data on ethnicity and country of origin or ancestry were obtained by self-report. From self-reports of years of schooling completed, we categorized education to correspond to academic credentials usually associated with socioeconomic position in the United States.

Analyses

Data on self-reported weight and height were missing for 88 (1.9%) of the respondents, who were excluded from all analyses. In addition, 5 respondents had implausibly large BMI values (>65 kg/m^2) and were excluded. With the remaining sample of 4556 respondents, we examined key characteristics and generational status for Latinos and Asian Americans separately, overall, and by subgroup. We estimated weighted mean BMI and prevalence of obesity (BMI $\geq$ 30 kg/m^2) for Latinos and Asian Americans overall and by subgroup and compared these values across generations within each group.

To further explore changes in the entire distribution of BMI across generations, we graphically represented the distributions with Tukey mean-difference plots.[30] Recent applications of this method have compared changes in BMI distributions over time in the United States and Canada.[31,32] We generated mean-difference plots separately for Latinos and Asian Americans, comparing within each the distributions of BMI for first versus second generation and for second versus third generation. The mean-difference plots were constructed by generating weighted BMI values corresponding to every even percentile level (2nd, 4th, 6th . . . 98th) of each distribution. For each generational comparison, we then created a scatterplot of the mean of the 2 BMI values (x-axis) and the difference between the 2 BMI values (y-axis) at each percentile level.

The mean-difference plots allowed a qualitative visual estimation of both the nature and degree of shifts in the distribution of a continuous variable of interest.[31] If the y-axis values were constant at zero across all values of mean BMI, there was no difference between the 2 distributions. Departures from zero on the y-axis indicated the magnitude of difference between the 2 distributions at a given mean level, and the pattern of that departure suggested where in the distributions difference existed and the extent to which it was uniform across values of mean BMI. A fuller discussion of mean-difference plots is available in Flegal and Troiano.[31]

Finally, to determine whether generational status was significantly associated with BMI while accounting for potential confounders, we fit multiple linear regression models of BMI on a dummy-coded categorical variable representing generational status, controlling for age, place of origin or ancestry, gender, and education. We chose to model BMI as a continuous outcome measure to avoid the statistical power limitations of a categorical analysis. We were also interested in understanding the potential effects of generational status on the entire BMI distribution, not just on 1 part (e.g., BMI $\geq$ 30 kg/m^2).

In these analyses, we tested for interactions between generation and gender, education, and ethnicity. Statistical analyses were conducted with Stata version 8 (StataCorp LP, College Station, Tex). To account for possible sample design effects, we used the SVYREG procedure for variance estimation.[33] We used sample weights to adjust for probability of selection and nonresponse.

RESULTS

Table 1 presents basic descriptive characteristics of the sample overall (column 1) and generational status for each subgroup (columns 2–4). Mexican immigrants and their descendants were the largest subgroup of Latinos, and "Other Asians" were the largest subgroup of Asian Americans (this subgroup had several countries of origin; the largest numbers came originally from Japan, India, and South Korea). In all subgroups the majority were immigrants, but among Asian Americans, Cubans, and those with low education (less than 12 years), the percentage of foreign born was especially high ($\geq$70%). Educational attainment was higher among Asian Americans than among Latinos.

Table 2 shows patterns in mean BMI and obesity prevalence by subgroup and across generations. Among all respondents (combining individuals regardless of generational status), mean BMI and proportion obese (BMI $\geq$ 30 kg/m^2) were considerably higher among Latinos than among Asian Americans overall and regardless of subgroup, but within each ethnic category there was significant heterogeneity. Among both Latinos and Asian Americans, mean BMI was higher in men than in women, but there were no statistically significant gender differences in obesity. Among Asian Americans, obesity prevalence was higher among persons with more education; among Latinos, the opposite was true, although the latter association was not statistically significant.

TABLE 1—Sample Weighted Percentages and Means of Latinos and Asian Americans, by Generational Status: National Latino and Asian American Survey, 2002–2003

	Total Sample		First Generation		Second Generation		Third Generation	
	Unweighted No.	% or Mean (SD)	Unweighted No.	% or Mean (SD)	Unweighted No.	% or Mean (SD)	Unweighted No.	% or Mean (SD)
Latinos	2480	73.0	1571	58.4	515	21.1	390	20.5
Asian Americans	2076	27.0	1629	77.1	268	13.6	179	9.3***
Latinos								
Place of origin								
Puerto Rico	490	10.4	214	45.3	163	33.6	113	21.1
Cuba	570	4.8	494	86.1	72	13.2	4	0.7
Mexico	820	55.6	450	56.7	188	21.8	182	21.5
Other	600	29.2	413	61.8	92	16.7	95	21.5***
Women	1363	47.2	856	58.3	287	21.7	220	20.1
Men	1117	52.8	715	58.5	228	20.6	174	20.9
Education, y								
< 12	942	43.3	698	72.2	130	14.5	114	13.3
12	622	25.0	354	47.7	135	24.0	133	28.4
13–15	560	21.4	295	45.0	163	28.8	102	26.2
≥ 16	356	10.3	224	52.0	87	26.9	45	21.0***
Age, y	2480	38 (14.7)	1571	39.1 (15.8)	515	36.4 (14.4)	394	36.6 (13.4)
Asian Americans								
Place of origin								
Vietnam	516	12.9	498	97.0	18	3.0	0	–
Philippines	500	21.4	345	70.6	112	22.7	43	6.8
China	597	28.9	474	82.1	72	11.0	51	6.8
Other	463	36.8	312	70.0	66	14.2	85	15.9***
Women	1081	52.1	860	78.6	136	13.2	85	8.3
Men	995	47.9	769	75.5	132	14.1	94	10.4
Education, y								
< 12	312	15.0	296	94.9	12	3.9	4	1.2
12	369	17.8	272	70.1	53	17.8	44	12.1
13–15	523	25.2	368	68.0	89	17.8	66	14.2
≥ 16	871	42.0	692	79.1	114	12.9	65	8.0*
Age, y	2076	41.3 (14.7)	1629	42.3 (14.2)	268	35.2 (17.0)	179	37.9 (13.3)

*$P < .05$; ***$P < .001$.

Statistically significant increases in BMI and obesity with succeeding generations were observed for the Chinese and "Other Asian" subgroups. Among Filipinos, increases in obesity were borderline significant ($P = .05$), and among Vietnamese, there was a statistically significant decrease in BMI and obesity between the first and second generation (and insufficient data to generate estimates for the third generation). Increases in BMI and obesity in succeeding generations were also evident among Latinos, although they were less statistically significant. The exception was among Puerto Ricans, in whom we observed a statistically significant decrease in obesity in later generations.

The mean-difference plots in Figure 1 and Figure 2 provide information about changes in the full distribution of BMI across generations. Among Latinos, the plots indicate that there was a gradually increasing upward shift at the higher end of the distribution (above mean BMI of 30 kg/m^2) in the second generation compared with the first. In the third generation (compared with the second), this upward shift began at a lower point in the distribution (at approximately mean BMI = 25 kg/m^2) and remained fairly constant until the most extreme upper bound of the distribution.

By contrast, among Asian Americans, an upward shift occurred in the second generation at every level of the distribution. The difference was slight (< 1 kg/m^2) below a mean BMI of 27 kg/m^2, but then large and progressively greater at the upper end of the distribution. Between the second and third generations, the full distribution of BMI also shifted upward, but the skewness of the distribution did not increase constantly: at the low end of the distribution, differences were increasingly large and then, above a mean BMI of

TABLE 2—Mean Body Mass Index (BMI) and Percentage Obese Among Latinos and Asian Americans, by Generational Status: National Latino and Asian American Survey, 2002–2003

	All Generations[a]		First Generation[b]		Second Generation[b]		Third Generation[b]	
	Mean BMI, kg/m^2 (SE)	% Obese (95% CI)	Mean BMI, kg/m^2 (SE)	% Obese (95% CI)	Mean BMI, kg/m^2 (SE)	% Obese (95% CI)	Mean BMI, kg/m^2 (SE)	% Obese (95% CI)
Latinos	28.0 (0.2)	29.1(26.7, 31.4)	27.6 (0.2)	25.4 (23.2, 27.7)	28.2 (0.3)	32.3 (26.4, 38.2)	28.8 (0.4)	35.7 (29.3, 42.2)*
Asian Americans	24.2 (0.1)***	9.4 (7.9, 11.0)***	23.8 (0.2)	6.9 (5.1, 8.7)	24.9 (0.3)	13.5 (9.2, 17.8)	26.6 (0.6)***	24.2 (16.4, 32.0)***
Latinos								
Place of origin								
Puerto Rican	27.8 (0.3)	29.8 (23.8, 35.7)	28.3 (0.5)	34.9 (27.8, 42.0)	27.7 (0.4)	26.6 (17.1, 36.0)	26.8 (0.7)	24.1 (16.7, 31.4)*
Cuban	27.3 (0.2)	21.7 (18.1, 25.3)	27.3 (0.2)	21.7 (17.7, 25.7)	27.0 (0.6)	21.8 (11.2, 32.3)	24.8 (2.2)	18.5 (−19.0, 56.0)
Mexican	28.5 (0.2)	32.5 (28.5, 36.5)	28.1 (0.4)	28.5 (24.5, 32.5)	28.7 (0.5)	37.3 (29.6, 45.0)	29.2 (0.6)	37.7 (28.4, 46.8)
Other	27.2 (0.2)***	23.5 (19.5, 27.5)***	26.6 (0.2)	18.5 (14.2, 22.9)	27.2 (0.7)	25.1 (13.4, 36.8)	28.9 (0.5)***	36.2 (26.5, 45.9)**
Gender								
Women	27.6 (0.2)	28.3 (25.2, 31.4)	27.2 (0.3)	26.5 (23.2, 29.9)	28.0 (0.4)	29.1 (21.7, 36.5)	28.2 (0.4)	32.3 (23.9, 40.8)
Men	28.3 (0.2)*	29.7 (26.5, 32.9)	27.9 (0.3)	24.5 (21.0, 27.9)	28.4 (0.5)	35.3 (27.6, 43.1)	29.4 (0.6)	38.7 (32.2, 45.2)**
Education, y								
≤12	28.0 (0.1)	30.4 (27.4, 33.5)	27.8 (0.3)	27.4 (24.7, 30.2)	28.0 (0.5)	33.8 (25.9, 41.7)	28.6 (0.5)	37.0 (29.7, 44.2)
≥13	27.8 (0.3)	26.1 (21.9, 30.3)	26.8 (0.3)	19.7 (14.9, 24.5)	28.4 (0.4)	30.2 (22.3, 38.0)	29.1 (0.5)***	33.6 (24.8, 42.5)*
Asian Americans								
Place of origin								
Vietnamese	22.4 (0.2)	2.5 (0.5, 4.5)	22.5 (0.2)	2.6 (0.5, 4.6)	20.3 (0.6)	0.0 (. . .)	. . .	. . .
Filipino	25.8 (0.2)	17.2 (13.2, 21.2)	25.4 (0.3)	13.6 (8.6, 18.6)	26.4 (0.6)	23.5 (15.2, 31.8)	27.3 (1.3)	33.3 (9.7, 56.9)
Chinese	23.1 (0.2)	4.3 (3.2, 5.4)	22.7 (0.2)	2.6 (1.2, 4.0)	23.7 (0.4)	6.0 (0.6, 11.4)	26.9 (0.8)	22.1 (15.1, 29.1)***
Other	25.0 (0.2)***	11.3 (7.4, 15.3)***	24.6 (0.2)	9.1 (5.4, 12.7)	24.6 (0.8)	9.7 (3.4, 15.9)	26.3 (0.7)	22.7 (12.9, 32.5)**
Gender								
Women	23.6 (0.2)	9.7 (7.1, 12.4)	23.2 (0.2)	7.5 (4.9, 10.1)	24.2 (0.5)	13.3 (9.1, 17.4)	25.4 (1.1)	25.0 (7.6, 42.4)*
Men	25.0 (0.2)***	9.1 (6.4, 11.8)	24.5 (0.2)	6.2 (4.5, 8.0)	25.6 (0.4)	13.7 (7.4, 20.0)	27.6 (0.6)	23.5 (10.2, 36.8)***
Education, y								
≤12	24.0 (0.2)	6.9 (3.8, 10.0)	23.5 (0.2)	4.4 (1.5, 7.3)	24.9 (0.5)	10.0 (1.7, 18.3)	27.6 (0.9)	31.1 (16.4, 45.9)***
≥13	24.4 (0.2)	10.6 (9.1, 12.1)*	24.0 (0.2)	8.2 (6.4, 10.1)	24.9 (0.4)	14.8 (11.7, 18.0)	26.3 (0.9)	21.9 (11.6, 32.3)**

Note. CI = confidence interval.
[a]Comparison across subpopulation groups. *P* values report significance levels for tests of overall differences in mean BMI and obesity prevalence by ethnicity, place of origin, gender, and education.
[b]Comparison across generations within subpopulation groups. *P* values report significance levels for tests of differences in mean BMI and obesity prevalence across generational status for each subgroup.
*$P<.05$; **$P<.01$; ***$P<.001$.

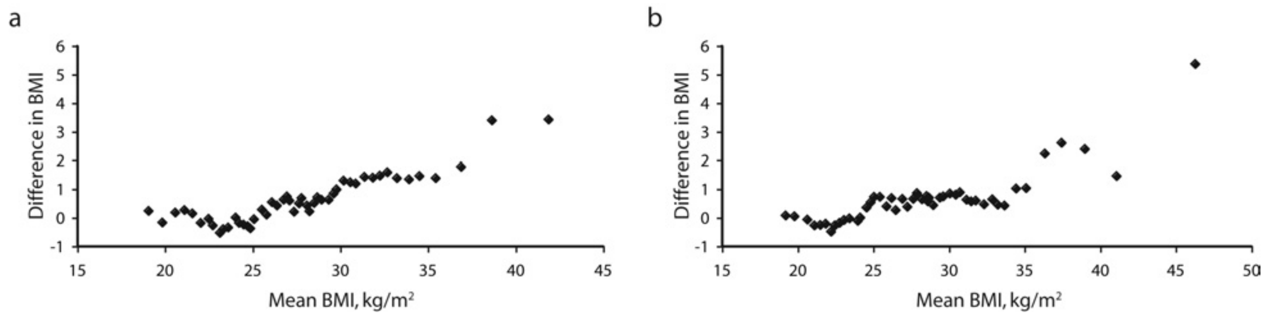
28 kg/m^2, increasingly small. Therefore, among Asian Americans, we found both a shift in the entire distribution of BMI and an upward skew in distribution with succeeding generations.

Table 3 presents the results of multiple regression analyses of the association between generational status and BMI. The analyses mostly confirmed the bivariate results, showing statistically significant increases in BMI in succeeding generations for both Latinos and Asian Americans overall and most ethnic-specific gender and education subgroups. There was very little evidence of confounding of the association between generational status and BMI by education, age, or gender. However, the association between generational status and BMI among Asian Americans was strongly confounded by country of origin or ancestry (results not shown). We did not observe any statistically significant interactions between generational status and ethnicity, gender, or education. A statistically significant difference in BMI between the second and third generations was evident only among Asian American men ($P=.01$) and Asian Americans with less education ($P=.03$).

DISCUSSION

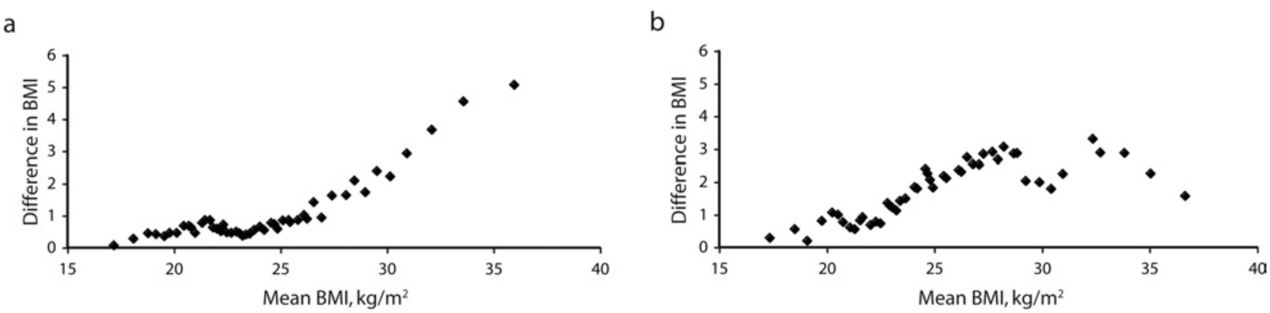
In a nationally representative sample of Latinos and Asian Americans in the United States, we found significant heterogeneity in estimates of BMI and obesity and an increase in mean BMI with succeeding generations among most subgroups considered. To our knowledge, these are the first analyses of patterns in adult BMI and obesity by generational status in the United States that compared multiple subgroups and distinguished between the second and third generation. Together, these findings underscore the importance of data on adiposity that is disaggregated by ethnic subgroup and generational status.

Our estimates of obesity among Asian Americans were on average lower than those observed in the US population as a whole, but the aggregate estimates masked the degree to



Note. The value on the x-axis equals the mean value of the BMI for the 2 groups being compared at a given percentile (2nd through 98th). The difference in these 2 BMI values is plotted on the y-axis.

FIGURE 1—Tukey mean-difference plots of distributions of body mass index (BMI) among Latinos, comparing (a) second with first generation and (b) third with second generation: National Latino and Asian American Survey, 2002–2003.



Note. The value on the x-axis equals the mean value of the BMI for the 2 groups being compared at a given percentile (2nd through 98th). The difference in these 2 BMI values is plotted on the y-axis.

FIGURE 2—Tukey mean-difference plots of distributions of body mass index (BMI) among Asian Americans, comparing (a) second with first generation and (b) third with second generation: National Latino and Asian American Survey, 2002–2003.

which obesity was increasing dramatically in succeeding generations and among certain subgroups, such as Filipinos, reaching levels in the third generation comparable to those in the general US population. These findings of considerable heterogeneity among Asians by country of origin and nativity are consistent with results reported elsewhere.[34] The levels of obesity we observed among Latinos were comparable to or higher than those in the general US population.

Immigrants are, in varying degrees (depending on age at and time since arrival), subject to influences of both the US context and the place of origin. Much of the observed heterogeneity in BMI and obesity across ethnic subgroups is therefore a function of differences in the timing and pace of the nutrition transition in the sending countries, namely, the shift from a dominant pattern of low-fat consumption and high energy expenditure to the inverse.[35] The high prevalence of obesity among individuals born in Puerto Rico and the atypical downward trend in later generations most likely reflect in part levels of obesity in Puerto Rico comparable to those on the mainland United States.[36] Furthermore, existing evidence, although mixed, suggests a lack of or relatively weak healthy-migrant effect among Puerto Ricans,[37–39] and Puerto Ricans are a notable exception to observed Latino health advantages in the United States.[40]

The National Latino and Asian American Survey was not designed to formally test for subgroup differences in associations between generation and BMI. We presented results stratified by subgroup to the extent possible to allow for qualitative assessment of variation and consistency in BMI patterns. Future studies may benefit from samples designed to formally test for differences in these patterns.

Our results are consistent with other studies that analyzed data from the National Health Interview Survey and found nativity differences in BMI and obesity among Asians[12] and Latinos,[17] but they suggest that the trends toward increasing BMI and obesity with succeeding generations may continue into at least the third generation, particularly among Asian Americans. Khan et al. also found differences in BMI among Mexican Americans in the second and third generations compared with the first.[15] Although the observed differences between third- and second-generation individuals were only statistically significant for Asian American men and Asian Americans with little education, the upward trend was fairly consistent across all subgroups. Our findings were comparable to those of Popkin and Udry,[16] who reported increased adiposity with later generations among a sample of young (aged 15–22 years)

TABLE 3—Multiple Linear Regression of Body Mass Index (BMI) on Generational Status Among Latinos and Asian Americans: National Latino and Asian American Survey, 2002–2003

Strata	First Generation, No.	Second Generation, b (95% CI)	Third Generation, b (95% CI)
Latinos			
All[a]	2480	1.25 (0.60, 1.90)***	1.56 (0.58, 2.54)**
Gender[b]			
Women	1363	1.38 (0.40, 2.37)**	1.33 (0.25, 2.41)*
Men	1117	1.14 (-0.11, 2.38)	1.76 (0.23, 3.30)
Education,[c] y			
≤12	1564	0.71 (-0.23, 1.65)	1.08 (-0.24, 2.40)
≥13	916	1.92 (0.92, 2.93)***	2.18 (1.01, 3.35)**
Asian Americans			
All[a]	2075	1.07 (0.49, 1.65)**	2.20 (0.84, 3.56)**
Gender[b]			
Women	1081	1.14 (0.18, 2.11)*	1.54 (-0.57, 3.66)
Men	994	1.03 (0.29, 1.77)**	2.86 (1.69, 4.04)***
Education,[c] y			
≤12	681	1.22 (0.00, 2.43)	3.25 (1.61, 4.89)***
≥13	1394	1.10 (0.25, 1.94)*	1.97 (0.18, 3.75)*

Note. b = unstandardized parameter estimates. For all categories, first generation is the reference group.
[a]Model controlled for age, place of origin/ancestry, education, and gender.
[b]Model controlled for age, place of origin/ancestry, and education.
[d]Model controlled for age, place of origin/ancestry, and gender.
*$P<.05$; **$P<.01$; ***$P<.001$.

Hispanics and Asian Americans, although they observed much smaller, nonstatistically significant differences between the second and third generations. They also found that differences between first and subsequent generations appeared more pronounced overall among Asian Americans than Hispanics.[16]

Among Asian Americans, we found that with each generation there was both an upward shift in the entire BMI distribution as well as an increasing upward skew. This pattern is consistent with Rose's argument that changes in the tails of a distribution of a given characteristic cannot be divorced from what is happening to the entire distribution.[41] Among Latinos, the distribution was increasingly skewed upward with succeeding generations, but the percentage in the normal and underweight categories (BM<25 kg/m^2) remained fairly constant. The nature of changes in the distribution of BMI has potential implications for strategies to both understand the etiology of obesity and develop interventions to prevent or reduce it. The distribution changes that represent an entire upward shift indicate influences on levels of obesity that affect the full population (suggesting the need for a population approach). The increased dispersion of the curves (the spread of the upper tail) suggests differential exposure or susceptibility, or both, to risk factors for obesity (indicating the need for a high-risk approach).

There were important limitations to this study. Most significant was the reliance on self-reported weight and height data. Although self-reporting is considered an acceptable method of ascertaining BMI and is widely used, systematic biases (e.g., underestimating weight and overestimating height) have been observed.[42–48] Factors associated with biased reporting include age, gender, mode of interview, education, race/ethnicity, and actual height or weight. We adjusted for all but the last of these factors in regression analyses; however, the validity of self-reported anthropometric measures by generational status and national-origin subgroup is largely unknown.[12]

Accuracy of self-reported weight and height could vary by access to health care as well as by the salience and cultural understanding of these concepts.[49] However, one of the few systematic investigations of this question, comparing immigrant to nonimmigrant Mexican Americans, concluded that self-reporting was accurate for both, except among those who were underweight.[50] Findings elsewhere that self-report data generated greater underestimates of overweight and obesity among Mexican Americans than among non-Hispanic Blacks and non-Hispanic Whites[51] suggest that our prevalence estimates were, if anything, conservative.

Our analyses were also significantly constrained by sample-size limitations. For example, although we found significant differences between the third and earlier generations of Asian Americans, the estimates for third-generation Asian Americans were imprecise, as indicated by the wide confidence intervals in Table 2. Similarly, we did not have sufficient power to examine in adjusted analyses the generational differences in BMI disaggregated by place of origin or ancestry. The significant limitations of panethnic categories have been noted elsewhere,[52] and we were not able to adequately account for the important heterogeneity among Latino and Asian American subgroups. For example, the aggregate adjusted estimate of the association between generation and BMI among Latinos may have masked a decrease or lack of change among Puerto Ricans and Cubans. Our results highlight the importance of adjusting for country of origin or ancestry in such aggregate estimates, especially among a sample of Asian Americans, given sizeable national origin differences in nativity and BMI. Finally, the high percentage of Asian Americans with unspecified national origins also limited our interpretation of the data.

Nevertheless, our findings of increasing BMI and obesity with succeeding generations among immigrants to the United States support a growing consensus regarding the important role of social and physical environmental influences on body weight.[53–57] As with trends in obesity in the general population of the United States, the increases in BMI across generations are occurring in too short a time to be largely driven by genetic factors alone. Hypothetical explanations for the intergenerational trends include (1) exposure to certain types of food, marketing, pricing, and physical infrastructure (e.g., building design and transportation) associated with increased BMI and obesity[53–57] and (2) within this context, the process of acculturation (whereby immigrants are posited to adopt the host community's practices with respect to diet and physical activity).[16–19]

An important additional question regarding the role of environmental influences on obesity is the timing of exposure over the life course. Obesity in early life is associated with adult obesity,[58] but the unique or synergistic influences of specific childhood exposures on later-life obesity are not well understood.[59] Our results showing differences in BMI between first- and second-generation Latinos and Asian Americans (particularly among Latinos) suggest that significant childhood exposure to the US environment may influence adult BMI, but our analyses could not disentangle the effect of any specific period of childhood exposure from total cumulative exposure. Future studies should examine the effects of age at arrival to the United States on BMI among the foreign born.

Our findings suggesting possible differences in BMI between second- and third-generation Latinos and Asian Americans (particularly among Asian Americans) also raise questions regarding parental influences on obesity. Intergenerational factors, including parental BMI, are known to influence childhood adiposity.[58–60] Because parental nativity is what distinguishes between the second and third generations, a focus on the influence of parental characteristics may help explain these patterns. In a study of generational effects on current smoking among immigrants, Acevedo-Garcia et al. disaggregated the second generation to account for differences by number of foreign-born parents.[29] Their results suggest that the relevant distinction is between having 2 foreign-born parents and having 1 or 2 US-born parents; they observed no difference in the odds of smoking associated with having 1 versus 2 US-born parents, but reduced odds among those with 2 foreign-born parents.

The finding of sizeable increases in BMI and obesity in succeeding generations, particularly among Asian Americans, indicates that ongoing changes in the demographic distribution of immigrant populations in the United States may result in significant increases in the overall prevalence of obesity. For certain groups these changes may also be associated with disproportionate increases in morbidity. For example, there is evidence of differential susceptibility to weight-related morbidity among Asians; Asian populations appear to be at higher risk for outcomes such as diabetes at a given level of adiposity. Regarding only the standard risk category of obese as clinically significant may not be appropriate for this group.[61] We found that, among Asian Americans, generational status was associated with a considerable upward shift in BMI levels well below this standard high-risk threshold.

Understanding dynamics by generation is increasingly important as the US born continue to grow as a proportion of Latino and Asian American populations; between 2000 and 2020 it is estimated that the second generation will account for 47% of the growth of the Latino population in the United States, compared with 25% between 1970 and 2000.[22] Accordingly, efforts to monitor trends in obesity should as much as possible disaggregate data by nativity and by country of origin or ancestry to avoid masking important sources of heterogeneity. Prevention strategists seeking to better understand how influences on obesity may be ameliorated will need to consider the ways immigrants and their offspring are both uniformly and variably at risk. ■

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Contributors

L.M. Bates originated the study, conducted all analyses, and wrote the original draft as part of her dissertation research at the Harvard School of Public Health. N. Krieger served as the dissertation advisor. N. Krieger, D. Acevedo-Garcia, and M. Alegría provided overall guidance on the study and extensive feedback on the design and interpretation of analyses. N. Krieger and D. Acevedo-Garcia also contributed substantial revisions to earlier versions of the text. All authors participated extensively in the final review and editing of the article.

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Human Participant Protection

The internal review board committees of Cambridge Health Alliance, the University of Washington, and the University of Michigan approved all study procedures. The analyses reported here were approved by the Harvard School of Public Health human subjects committee.

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